REMARKS

Claims 28-47 are pending in the present application. Applicants herein amend claims 28, 30, 35-38, 40 and 44-46, and cancels claims 31, 33 and 42. After entry of these amendments, claims 28-30, 32, 34-41, and 43-47 remain pending in this application. Applicants respectfully request allowance of these pending claims of the present application in view of these amendments and in view of the remarks and arguments provided herein.

Claim Rejections under 35 USC 112

The rejections under 35 USC 112 are discussed herein with reference made to the section numbering of the Final Office action.

As to section 4, Applicants amend independent claims 28 and 38 to specifically state that the diffusion agent comprises aluminum and cobalt. The Final Office action acknowledges that this is enabled for these claims. Also, claims 30 and 40 are amended to clarify that silicon or carbon may be provided in addition to aluminum and cobalt. This is supported, inter alia, in the specification, paragraph 0033, which provides that a "multi-component diffusion agent 16" is applied to the corroded component 1 ("or at least one component of the diffusion agent 16 diffuses into the component 1 directly from the gas phase . . . "). It is noted that the term "element" is provided in the amendments to distinguish from the "component" which is taken to be the metal component first referred to in the preamble of claims 28 and 38.

As to section 5, Applicants amend independent claims 28 and 38 to specifically add heat treatment. The claim as amended is clearly supported by paragraph 0035. As to the second paragraph of this section, independent claims 28 and 38 are amended to overcome this basis of rejection (now indicating that at least one said element of the diffusion agent diffuses into the component directly from a gas phase and the diffusion involves heat treatment.

Further as to section 5 rejections, third paragraph, the Office action states that "the examiner can not locate proper support in the specification" for the claim requiring "both the degraded and the non-degraded[d] [sic] regions [to] [sic] exhibit a more

uniform reactivity." Applicants respectfully disagree. The last sentence of paragraph 0034 states, "The diffusion and heat treatment can also give rise to the formation of new phases which can be removed more easily by an acid bath 19 (FIG. 4)." Paragraph 0038 states, "On the other hand, enriching the MCrAlY layer with aluminum and/or cobalt causes γ and γ' phase to be converted into an aluminum-rich β phase." Then paragraph 0039 states, "The enrichment with the elements or the phase transformation described allows improved acid attack." Paragraphs 0040 through 0043 then describe FIGs. 4-6, which compare acid attack on a prior art treated versus a current application treated component which are exposed to acid attack for the same time. Critically, paragraph 0043 states regarding a component treated according to the current invention, "By contrast, FIG. 6 shows a component 1 or layer system 14 in which a layer area of the component I or the layer 10 has been removed uniformly." In that the right-hand component of FIG. 4 shows corrosion products 4 in two areas of the layer that is removed in FIG. 6, meaning that the other areas of that layer were not degraded, in view of the above logic compels that the invention teaches "that both degraded and non-degraded regions of the bonding layer exhibit a more uniform reactivity in the acid bath." The specification relates the acid reactivity of the degraded regions with the non-degraded regions by comparing the complete removal of the top layer in FIG. 6 with the incomplete removal of the analogous layer in FIG. 5, where both of these components are shown being subjected to acid treatment in FIG. 4 (see paragraphs 0023 and 0024 also for confirmation of this).

By the amendments made to claims 28 and 38, and to claims 35-37 and 44-47, it is believed that the 35 USC 112, first paragraph rejection to claims 35-37 and 44-47 are overcome. It is noted that paragraph 0017 provides support for these specific well-known methods to be applied in the present invention.

Regarding the rejection stated in section 7, page 5, it is believed that the above amendments, particularly related in claims 28 and 38 to clarifying the aspect of completely diffusing wherein "at least one said element of the diffusion agent diffuses into the component directly from a gas phase," and the related amendments of rejected claims 35-37 and 44-47, overcome this rejection. That is, it is now clear that at least one said element of the diffusion agent diffuses into the component directly from a gas

phase by any one of the following methods specified in the dependent claims (these methods being well-known in the art, and applicable without undue experimentation): plasma spraying; evaporation coating; and chemical vapor deposition.

Based on the above, including amendments and provision of support for indicated limitations, reconsideration and withdrawal of the 35 USC 112 rejections are respectfully requested.

Claim Rejections under 35 USC 102

Claims 28-34 and 38-43 stand rejected under 35 USC 102(a) as being allegedly anticipated by Czech et al. (WO 03/029521, US 2004/0244817).

First, it is noted that Applicants' file shows that an English translation of the PCT priority application was provided with the 35 USC 371 filing on November 29, 2004. This appears to be identified as the "specification" rather than the English translation of the priority document in the PAIR Image File. It is not clear to the Applicants why the English language translation of the PCT publication is not properly identified in the PAIR Image File. A copy of this translation is provided herewith, together with a copy of the post card sent by the Applicant with the patent application transmittal and stamped with a receipt confirmation by the USPTO, and a copy of the substitute specification (which should be entered in PAIR as the specification). Entry (and correction of records as needed) is respectfully requested. Thus, reliance on the foreign priority application is proper, and this removes Czech et al. as a prior art reference.

Furthermore, and notwithstanding the above, Czech et al. do not anticipate the present invention. This reference is directed to applying a multicomponent cleaning agent particularly to areas comprising the corrosion products (see paragraphs 0053 and 0055 among others) and the claims are directed to "locally applying a multicomponent cleaning agent to one surface of a corroded part." Contrary to statements in the Office action, this reference does not enablingly teach complete diffusing of a diffusion agent into the entire bonding layer according to the limitations of the present claims. As but one example of this, Czech et al. do not teach a method wherein at least one said element of the diffusion agent diffuses into the component directly from a gas phase. It

must be concluded that the allusion to an inherency argument, in the first full paragraph of page 7, is not proper.

The above arguments apply to the rejected independent claims, and to the rejected claims depending from these. Reconsideration and withdrawal of this rejection is respectfully requested.

Finally, with regard to previous 35 USC 102 rejections, it is noted that Draghi et al. (US 6,042,879) does not teach all limitations of either of the amended independent claims, 28 and 41. Reasoning in the previously provided response is applicable to the present claims.

Claim Rejections under 35 USC 103

Claims 28-30, 33-34, 36-43, and 45-47 stand rejected under 35 USC 103(a) as being allegedly unpatentable over Czech et al. (WO 03/029521, US 2004/0244817) in view of Draghi et al. (US 6,042,879)

Claims 31-32 stand rejected under 35 USC 103(a) as being unpatentable over Czech '668 in view of Draghi as applied above and further in view of Argyriades et al. (US 3,184,292).

In that Applicants have moved the limitations of claim 31 into independent claims 28 and 38, the rejection of claim 31, based on all three references, is now relevant to independent claims 28 and 38. As to use of these three references in combination, Applicants respectfully assert that a prima facie case of obviousness has not been made. This is because Argyriades et al. '292 is directed to coating refractory metals, rather than a method of refinishing a metal component (see entire patent, including Example XXIV, and col. 7, lines 11-58). The Patent Office has not provided any evidence or argument why a diffusion process to form an oxidation resistant diffusion alloy coating on a refractory metal would be recognized as suitable for a process that uses diffusion of two or more elements of a diffusion agent to penetrate a partially oxidized or otherwise degraded layer of a metal component where that diffusion results in more uniform removal of the layer in a subsequent step. Also, there is no suggestion or motivation to combine the references based on these differences in the foci of the respective references, and on the uncertainty of success of applying methods and

components used for formation of a coating to a multi-step method for removal of a bonding layer comprising degraded regions.

Accordingly, reconsideration and withdrawal of this rejection for the pending claims are respectfully requested.

Conclusion

The present amendments do not add limitations not already present in the claims or indicated as proper in the Office action. No new matter is added, and entry of these amendments under 37 CFR 1.116 and allowance of the claims as amended are respectfully requested. In the alternative, entry of the amendments is requested to place the claims in better condition for consideration upon appeal, should allowance not be forthcoming.

The Commissioner is hereby authorized to charge any appropriate fees due in connection with this paper, including the fees specified in 37 C.F.R. §§ 1.16 (c), 1.17(a)(1) and 1.20(d), or credit any overpayments to Deposit Account No. 19-2179.

Respectfully submitted,

Dated: 10/19/06

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TO THE U.S. PATENT & TRADEMARK OFFICE
Please stamp the date of receipt of the following documents and return this card to us.

EXPRESS MAIL LABEL: ED 337412731 US
Application number: Not Yet Assigned 10/516085
Filing Date: November 29, 2004
Title: METHOD FOR REMOVING AT LEAST ONE PARTIAL AREA OF A COMPONENT MADE OF METAL OR A METAL COMPOUND
Inventors: Ralph Reiche, Werner Stamm
enclosed in package: Form PTO-1390 Transmittal Letter to the United States Designated/Elected Office (DO/EO/US) Concerning A Filing Under 35 U.S.C. 371 (2 pgs. original + 2 pgs copy); 10 Pg. Application in the German Language and 2 pgs of drawings; 12 Pg. Translation document/application including 9 pgs. of spec., 3 pgs. of claims; 2 Sheet(s) of drawings containing 6 figures; Declaration & POA (4 pgs.); 3 pg. Amended Sheets to PCT application filed in the German language on April 19, 2004; 3 pg. Translation Amendment Sheets to PCT application; Information Disclosure Statement by Applicant (1 pg.); copies of 16 cited references; Assignment Cover Sheet (2 copies) and Assignment (3 pgs); Preliminary Amendment (6 pgs.); Substitute Specification (10 pgs.); Cover Sheet of published PCT application PCT/EP03/05573; International Search Report (4 pgs.).
Patent Fees of $1,100.00 and Assignment recordation fee of $40.00 paid by deposit account.

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ATTORNEY: John P. Musone JPM

Method for removing at least one partial area of a component made of metal or a metal compound

Field of the invention

The invention relates to a method for removing a partial area, in particular a layer area, of a component consisting of metal or a metal compound, so that the partial area can be removed more easily after the method has been applied.

Background of the invention

In modern energy generation plants, such as for example gas turbine installations, efficiency plays an important role, since it is a parameter which can be used to reduce the costs of operation of the gas turbine installation. One possible way of increasing the efficiency and thereby reducing the operating costs is to increase inlet temperatures of a combustion gas within a gas turbine.

For this reason, ceramic thermal barrier coatings have been developed and are applied to components that are subject to thermal loading, for example made from superalloys, which are no longer able to withstand even the high inlet temperatures over the course of time.

The ceramic thermal barrier coating offers the advantage of a high thermal stability on account of its ceramic properties, and the metallic substrate offers the advantage of good mechanical properties in this assembly or layer system.

A bonding layer of composition

MCrAlY (main constituents), in which M means that a metal comprising nickel, chromium or iron is used, is typically applied between the substrate and the ceramic thermal barrier coating.

The composition of these MCrAlY layers may vary, but despite the ceramic layer on top of them, all MCrAlY layers are subject to corrosion or degradation as a result of oxidation, sulfiding, nitriding, diffusion or other chemical and/or mechanical attacks.

It is often the case that the MCrAlY layer is degraded to a greater extent than the metallic substrate, i.e. the service life of the composite system comprising substrate and layer is determined by the service life of the MCrAlY layer.
After prolonged use, the MCrAlY interlayer only has a limited ability to function, whereas the substrate may still be fully functional.

Therefore, there is a need for the components which have been degraded in use, for example turbine blades, guide vanes or combustion chamber parts, to be reworked, during which process the corroded layers of the zones of the MCrAlY layer have to be removed in order if appropriate for new MCrAlY layers and/or then a thermal barrier coating to be applied. The use of existing, used substrates reduces the costs of operation of gas turbine installations.

In this context, it must be ensured that the design of the turbine blades is not altered, i.e. that there is a uniform removal of material from the surface.

Furthermore, there should be no residues of corrosion products, which represent a defect source during new coating with an MCrAlY layer and/or a ceramic thermal barrier coating and lead to poor bonding of the thermal

barrier coating.

A method for removing corrosion products is known from US-A 6,217,668. In this method, the corroded component is accommodated in a large crucible, where the component is arranged in a powder bed with an aluminum source. The crucible must be partially closed and then heated in a furnace. The heating process supplies aluminum to the corroded component, with the result that the regions which had hitherto been more difficult to remove, i.e. which had a higher resistance to removal, can be removed by means of subsequent acid treatment. Large amounts of material are required for the powder bed, and the crucible takes up a large amount of space in the furnace during the heat treatment. The heating process also lasts longer, on account of the high heat capacity.

A further method for removing surface layers of metallic coatings is known from US-A 6,036,995. In this method, an aluminum source is applied to a corroded component in the form of a paste. However, the component together with the paste has to be heated until the aluminum melts, and consequently it is only then that aluminum can diffuse into the component. The molten aluminum layer is difficult to remove, since it bonds very well to the component.

Description of the invention

The invention overcomes the described drawbacks by means of a method as described in claim 1.

Further advantageous configurations of the method are listed in the subclaims.

The diffusion agent can be applied by simple, known coating methods, such as plasma spraying, evaporation coating, CVD, pack

methods (component in a powder bed) or other methods (paste application).

The figures illustrate exemplary embodiments of the method according to the invention.

In the drawings:
figure 1 shows a corroded metallic component,
figure 2 shows a component to which the diffusion agent has been applied,
figure 3 shows the component illustrated in fig. 2 following a heat treatment,
figure 4 shows components which are being subjected to an acid treatment,
figures 5, 6 show components after an acid treatment for a method according to the invention and a method according to the prior art.

Description of the exemplary embodiments

Figure 1 shows a component 1 made of metal, a metal alloy and/or a metal compound, which in at least one partial area at a surface 13 and/or in the interior of the component 1 has corrosion products 4 which are present, for example, in regions formed separated from one another. The corrosion products 4 may also be linked together or may be present on/underneath the entire surface 13, i.e. may also form a corrosion layer 4.
By way of example, the region enclosed by a dot-dashed line represents a partial area 28.
The component 1 may be a bulk component or a layer or a region of a composite or layer system 14. In the case of a layer system 14, there is a substrate 7 made from metal or ceramic, to which the metallic layer 10, for example an MCrAlY layer, has been applied; M indicates that a metal composed of nickel, chromium or iron is used.

The partial area 28 may also be a partial area of the layer 10 or may represent the entire layer 10 of the layer system 14 and/or part of the metallic substrate 7.

The corrosion products 4 have formed while the component 1 was in use and are undesirable for further use of the component and need to be removed. This is often done by a treatment in an acid bath.

However, it is also the case that the material of the component 1 beneath or above the layer 10 of degraded regions and/or the corrosion products 4 have a different reactivity in an acid bath, i.e. are more resistant to removal. The different solubility in the acid bath is caused by the different solubility of the corrosion products 4 or because an original composition of the material of the component 1 or the layer 10 has changed, e.g. because the corrosion product 4 removes a component from a region of the component 1 in the region around the corrosion product 4, where it produces a depletion region. This leads to nonuniform removal or even no removal of the corrosion products 4 or the material in the depletion region.

The method according to the invention makes it possible to remove the corrosion products or the altered layer or base material regions completely and uniformly with the material of the component 1 or the layer 10.

By way of example, in a first method step coarse removal of the corrosion products 4 or other regions can be effected by mechanical methods, such as for example sand blasting and/or chemical means, such as for example an acid bath.

In a further method step (fig. 2), a multi-component diffusion agent 16 is, for example, applied to the

corroded component 1 on the surface 13, in particular in the region having the

corrosion products 4, or to the corrosion layer 4, or at least one component of the diffusion agent 16 diffuses into the component 1 directly from the gas phase, the corrosion products 4 in this example representing the regions which are more resistant to removal.

The diffusion agent 16 contains, for example, two components, both of which diffuse into the layer 10 or the component 1 as a result of a heat treatment, where they alter the chemical composition and materials. The diffusion and heat treatment can also give rise to the formation of new phases which can be removed more easily by an acid bath 19 (fig. 4).

Figure 3 shows a component as shown in figure 2, in which the diffusion agent 16 has completely diffused into the layer 10 as a result of a heat treatment at a temperature T. The layer 10 represents the partial area 28 that is to be removed, comprising not just regions that are more resistant to removal. The diffusion agent 16 is made up of at least two components. At least one component of the diffusion agent 16 is, for example, metallic, such as for example aluminum. By way of example, cobalt represents a further metallic component. Other components may include silicon or carbon.

The method functions particularly well if cobalt and aluminum diffuse into the partial area 28 as components of the diffusion agent 16.

In the example of an MCrAlY protective layer (M = Fe, Ni, Co), the γ' phase is prevented from re-forming.

On the other hand, enriching the MCrAlY layer with aluminum and/or cobalt causes γ and γ' phase to be converted into an aluminum-rich β phase.

The enrichment with the elements or the phase transformation described allows improved acid attack.

Figure 4 shows two components which are arranged in an acid bath 19 or are exposed to an acid attack.
The component 1 or the layer system 14 and a component 22 according to the prior art, on which the method according to the invention has not been carried out, have corrosion products 4 and are exposed to the acid attack for the same time.

Figure 5 shows the component 22 following the acid treatment. The component 22 still has acid-resistant regions 25 which have not been removed or have been removed to a lesser extent during the acid attack, resulting in nonuniform removal of a layer area of the component 22.

By contrast, Figure 6 shows a component 1 or layer system 14 in which a layer area of the component 1 or the layer 10 has been removed uniformly.

The diffusion of the diffusion agent 16 has also enabled the partial area 28 to become so brittle that the partial area 28 can be removed by a mechanical treatment (sand blasting, ultrasound, dry ice blasting).

Patent Claims

1. A method for removing at least one partial area, in particular a layer area, of a component made of metal and/or at least one metal compound, in which the partial area is removed by an acid treatment or a mechanical treatment, a diffusion agent (16) made up of at least two components diffusing at least into the partial area (28) of the component (1) in an intermediate step, at least two components of the diffusion agent (16) which diffuse into the component (1) being metallic.

2. The method as claimed in claim 1, characterized in that at least one component of the diffusion agent (16) is metallic.

3. The method as claimed in claim 1, characterized in that one component of the diffusion agent (16) is formed from aluminum.

4. The method as claimed in claim 1, characterized in that one component of the diffusion agent (16) is formed from cobalt.

5. The method as claimed in claim 1, characterized in that

the two-component diffusion agent (16) consists of cobalt and aluminum.

6. The method as claimed in claim 1, characterized in that the diffusion agent (16) is applied to a surface (13) of the component (1).

7. The method as claimed in claim 6, characterized in that the diffusion agent (16) is applied by plasma spraying.

8. The method as claimed in claim 6, characterized in that the diffusion agent (16) is applied by evaporation coating.

9. The method as claimed in claim 6, characterized in that the diffusion agent (16) is applied by CVD (chemical vapor deposition).

10. The method as claimed in claim 6, characterized in that the diffusion agent (16) is applied by a pack method.

11. The method as claimed in claim 1, characterized in that the diffusion effects at least one phase change in the component (1) or partial area (28).

12. The method as claimed in claim 1, characterized in that the partial area (28) is an MCrAlY layer (10), where M stands for an element iron, cobalt or nickel.

FIG 1

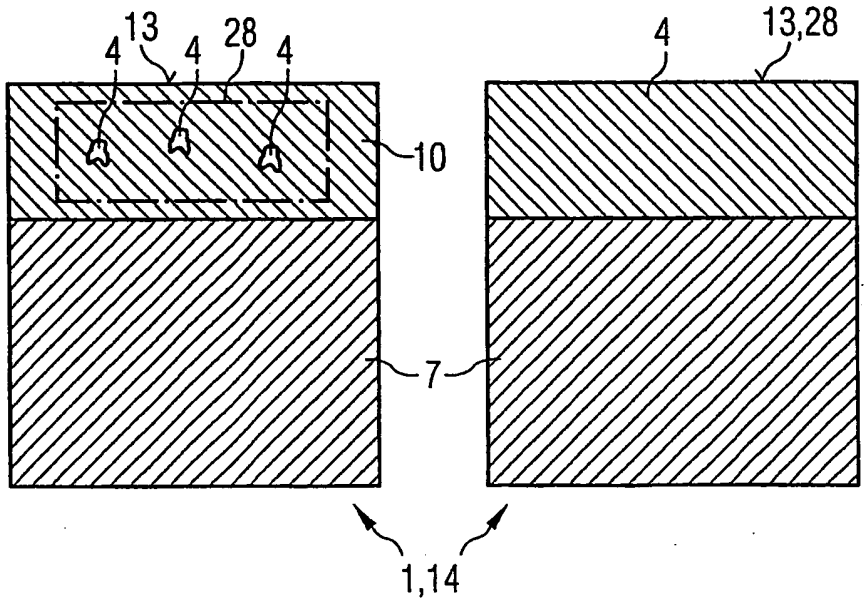

FIG 2

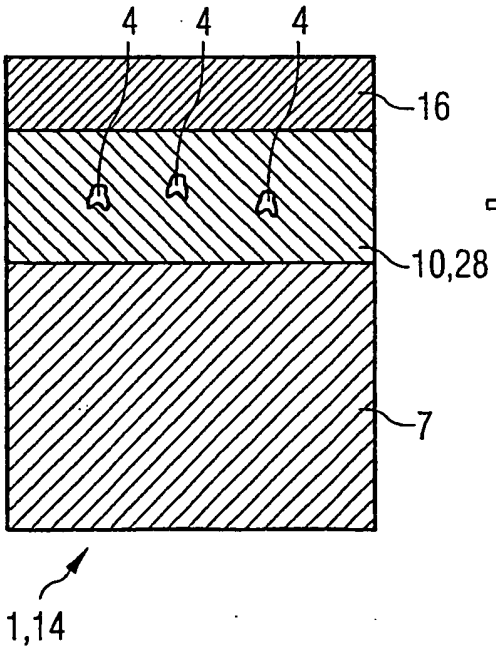

FIG 3

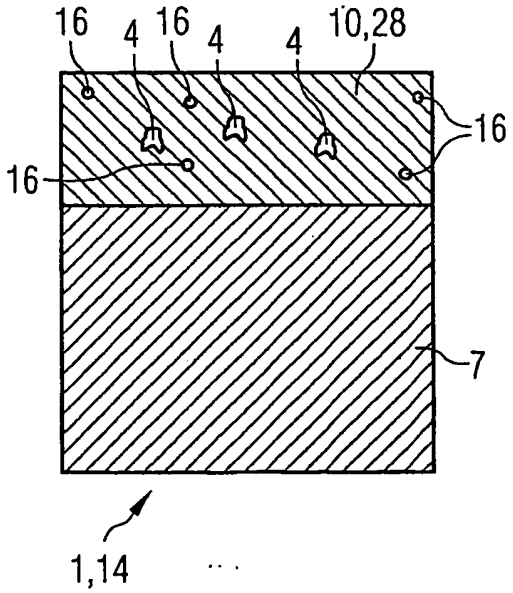

FIG 4

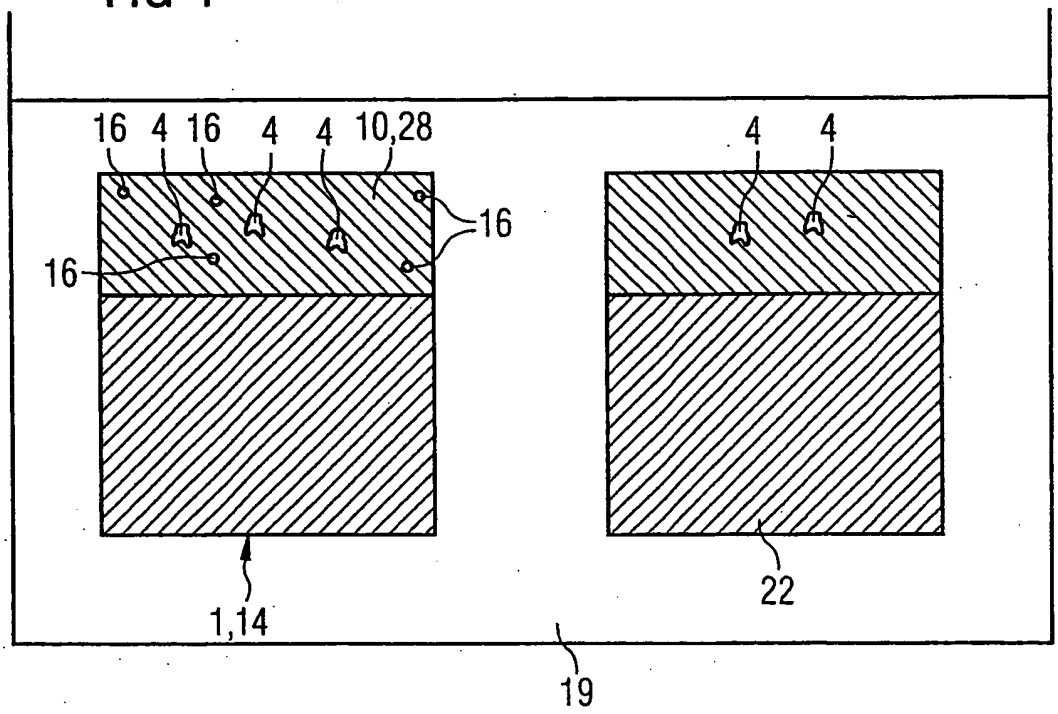

FIG 5

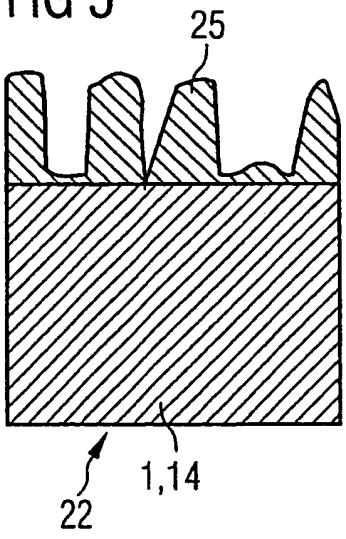

FIG 6